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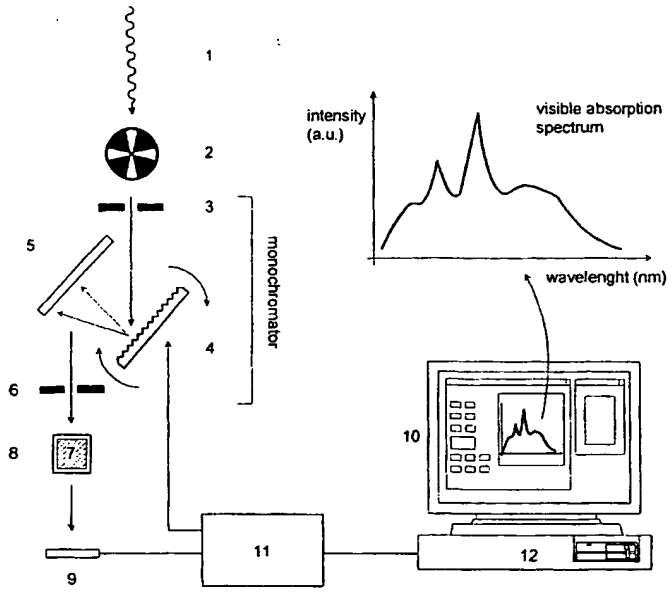
(54) Title: TEST METHOD



(57) Abstract: This invention relates to a practical low cost method and devices which exploits the benefits of several photo-assisted analytical techniques involving controlled light sources. The method comprise the use of a program controlled display (like computer, mobile telephones to TV screens) used as a light source for illuminating a detector specially suited to capture the light interaction with a test environment, allowing to generate distinctive spectra and chemical or biochemical images of the environment. Additionally, the information can be acquired in situ but immediately analyzed on line via internet.

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Test method

Background of the invention

There is a broad range of analytical techniques which rely on light interaction with a particular medium, as for example visible absorption spectroscopy (VIS spectroscopy), surface photovoltage spectroscopy (SPS), or scanning light pulse techniques (SLPT or LAPS) used in chemical or biochemical sensing.

All of them provide useful and complementary information of the target environment (hereinafter sometimes referred to as an "analyte") but due to the complexity of the systems, which are mainly related to the requirements for the light sources, their extension to practical applications is hampered, being in general confined to expensively furnished laboratories or to devices dedicated for specific purposes.

The complexity and sophistication of the involved light sources comprised in these experiments, relate to the optical components and the controlled micro-positioning required to direct the monochromatized light through the output slit.

The objective of the present invention is to provide a practical low cost method and associated devices which supplies micro-positioning, monochromatization and intensity modulation allowing to exploit benefits from the above mentioned techniques and others requiring precisely controlled light sources.

The invented method in general terms, consists of the use of a program controlled display (like computer monitors, mobile telephones or TV screens) as a light source. The mechanical positioning is substituted by the ability of the screen to sequentially illuminate contiguous pixels, precisely and regularly patterned in any of the different alluded displays. Instead of a monochromator this same accurate positioning can be used to monochromatize light using a

illuminated region on the screen as a mobile light source in front of a fixed diffractive element specially placed in front of the light.

Additionally, different RGB colors just sequentially displayed in the screen provide a light source suitable with spectral response measurements, which is a main goal for colorimetric sensing approaches. Furthermore the different pixels in the light source can be individually programmed with respect to color and intensity. Through the use of a lens between the light source and the test object also small test objects can be illuminated. The use of a program controlled display as a light source makes it also possible to scan the light over the test object.

The alluded light source can be used together with many types of light detectors to record the result of the illumination of the test object.

The use of detectors like digital cameras, video and web cameras is thus one interesting possibility.

The invention allows for instance simplified illumination of a test sample and/or detector specially designed to be affected by a target environment. In this respect already developed indicator materials or molecules for optical detection using normal (monochromatic) light sources can be used. It is also the possibility to develop indicators which are optimized to be used together with rgb-colors.

Additionally, the information can be processed in situ by the user or only acquired in situ but analyzed on line through an internet connection, where expert interpretation can be supplied.

The general inventive principle mentioned above, has particular characteristics depending on the considered analytical technique that is to be emulated.

For instance, in the case of VIS spectroscopy, the standard technique requires a visible light source, a monochromator, a chopper and a detector.

The monochromatized light, with a narrow spectral width determined by the monochromator

slit width, is passed through a transparent cuvette where the sample substance is placed, in this case a liquid, and the emerging light is captured in a detector. Depending on the detector requirements a light chopper can be interposed in the light path (Fig.1).

The VIS absorbing properties of different materials depend on their composition, and by the introduction of chemical agents (like chromophores or fluorescent labels) a large amount of chemical or biochemical properties can be traced and selectively identified through their spectral response.

The principle is not only limited to liquids, but also absorbing solids, gels or polymers like labeled DNA array slides or gas sensitive polymers can be analyzed.

Spectra acquisition requires a computer controlled system able to coordinate the supplied wavelength and this minimally comprises a programmable monochromator constraining the technique to laboratories.

In the case of SPS, or similar techniques used in semiconductor interface analysis like electric field induced SPS (EFISPS) or internal photoemission spectroscopy (IPE), the main principle is to excite carriers in semiconductor structures which are illuminated at a particular wavelength. The spectral range to scan depends on the semiconductor band gap but also sub-band gap energies can provide information of surface states.

In SPS, a focused monochromatic light beam is used to illuminate the semiconductor substrate at a controlled chopping frequency, which provides transient photocurrents related to surface or interface states (a complete review of SPS and related techniques can be found in L. Kronik, Y. Shapira, *Surf. Sci. Reports* 37, 1-206 (1999)). The technique, can be adapted for sensing applications, but still requires an expensive controlled light source (Fig.2).

If the light beam or a laser beam is scanned over the semiconductor, a spatially resolved map of the interface properties can be composed in the so called SLPT techniques (I. Lundström, et al., *Nature* 352, 47-50 (1991)). Providing chemically sensitive biasing electrodes of different

materials and thicknesses spatially distributed the technique provides selective chemical images to gas mixtures and odors (Fig.3).

If the biasing electrode is replaced by an electrolyte the device becomes a powerful potentiometric tool for chemical or biochemical analysis known as light addressable potentiometric sensor (LAPS, D. Hafeman, et al., *Science* 240, 1182-1185 (1988)).

In many of these approaches again, there are complex elements as micropositioned modulated laser beams with the associated focusing optics which makes field applications impracticable.

Summary of the invention

The object of the invention is achieved in a simple way by replacing the complex illuminating systems by a screen or display commanded by software.

In this way the display already used to visualize results and to provide a user interface required in all of these computerized techniques, may become a large area light source with configurable properties able to supply all the techniques simultaneously.

Firstly analyzing the VIS spectroscopy, if we consider that for many applications what is required from a spectrum is just its fingerprint capacity to identify a particular analyte, this is achievable by successively displaying RGB colors (color scanning) in a region of the display used as light source.

For instance, a cathode-ray tube (CRT) computer monitor, from the point of view of our goals, is a light source where a sweeping electron beam, excites a matrix of phosphorous dots which coat the screen on its inner side.

Phosphorous materials are chemicals which emit light when excited by a stream of electrons,

and different phosphorous materials emit differently colored light. In the case of CRT color monitors each dot in the screen consist of three blobs of blue, red and green emitting phosphors, which make up what is known as a single pixel. Different intensities of each color can create the illusion (for the human eye) of many different colors and within a broad range of intensities. Actually each individual color (red, green and blue) does not consist of a monochromatic source but a particular intensity distribution instead ($R(\lambda)$,$G(\lambda)$ and $B(\lambda)$ as illustrated in Fig. 4). What is emitted from the display is the sum of individual spectra weighted by r, g and b values individually ranging from 0 to 1 (0 to 255 for the individual rgb channels of a 24 bits video card):

$$\text{Emitted color}(\lambda) = r \times R(\lambda) + g \times G(\lambda) + b \times B(\lambda)$$

The combination of different possible rgb values provides a range of circa 16 millions of colors. If a set of rgb colors is arbitrarily chosen to imitate the visible spectrum perception, the emitted spectra are like those indicated in Fig. 5

This set can be used to perform multi-wavelength color scanning retaining the ability to generate distinctive absorption spectra (Fig. 6).

In Fig. 6 the test sample can be either a liquid contained in a cuvette or a material on a transparent substrate reacting on target species in the test environment. Numerous indicator systems for the detection of dissolved and gaseous species have already been developed (for instance for biosensing applications in R. Jelinek, S. Kolusheva, *Biotechnology advances* 19, 109-118 (2001), vapor sensitive porphyrines in N. Rakow, K. Suslick, *Science* 406, 710-713 (2000)). Many of them are applicable in the present invention without modification. We envisage, however, the possibility to develop indicators optimized for the use of rgb-based colors. In the first implementation of the invention it consists of the programmable light source

(monitor, display, mobile phone, TV-screen), which provides a controlled sequence of rgb colors, a test sample (a liquid or a solid-like material) designed to change its spectral response in the presence of an analyte to be detected (hormones, toxins, environmental pollutants, poisonous gases, etc.), and a light detector. Not discussed but obvious is also the necessity to provide means of bringing the test environment in contact with the sample.

In this new approach the monochromator is completely replaced by an easily available system without mobile parts which also provides an intrinsic chopping intensity required for some types of light detectors.

This is because, once excited by the electron beam the pixel intensity decays until the next time the beam reaches it in its scanning cycle. For a typical pixel frequency (also called refresh frequency) of 85 Hz, this constitutes an intrinsic chopping frequency for an individual pixel light source.

Larger light sources and higher total light fluxes on the sample can be produced by exiting groups of several pixels. The light from the sample can be focussed into the detector to increase the intensity on each pixel of the detector. Continuous horizontal pixels are excited with a delay of ~14 ns for a 1024 x 648 pixels resolution, and continuous vertical ones each ~14 μs (~71 kHz), but the 85 Hz chopping patterns are dominating compared with the high frequency superposition.

Regarding the detectors, these can be of different types, like large area metal-oxide-semiconductor devices, digital or video cameras, polymer photo-detectors or conductive photo-sensitive sensors which depending on the particular application can be patterned on a flexible or rigid substrate. Regarding the optical properties of the sample substance not only light absorption but also fluorescence is possible to monitor.

When a liquid crystal display (LCD) monitor is used instead of a CRT, the refresh frequency has a different meaning. In this kind of screens each pixel intensity remains constant until the next scanning cycle cause a change or not depending on the information that is to be displayed. If the detector requires a chopped light source, this can be introduced by switching on and off the illuminated region in each refresh cycle. Of course this approach is also suitable to CRT screens if excitation frequencies lower than the refresh frequency are required.

The case of surface photovoltage spectroscopies follows the same considerations given above but there is also chemical or biochemical interaction with the sensing device in addition to the absorption that may occur. These devices can e.g. be semiconductor samples with transparent electrodes (e.g. indium thin oxide -ITO), metal-insulator-semiconductor (MIS) structures, suspended gate MIS devices or electrochemical sensors, where the interaction with the analyte also changes the electrical properties of the light detector itself.

The light source can be reduced to an individual pixel, still preserving the light properties already described, with sizes around 250 μm by side and scanning pitch in the same range. In these conditions this tiny light source (or also other composed by several illuminated pixels) can be spatially scanned over a large area sensing device in the same fashion as the standard SLPT or LAPS but eliminating expensive and complex micropositioning tables and focusing optics.

Regarding the detector itself, for this kind of application similar devices as used in the standard technique can be exploited in the display assisted version.

Also combinations of VIS spectroscopy and large area, normally spatially scanned, devices can

be envisaged. For instance, DNA-chips are vehicles for the investigation of genetic information in biological samples. The DNA-chips are thus important tools for present genomics research and as well as for medical diagnosis. These chips may contain up to several thousands of individual measurement spots often covering an area of some few square centimeters. They are in general interrogated using fluorescent marked oligonucleotides, which express some particular property of the biological sample, generating a distinctive pattern in the distribution of spectral responses of the array.

If the same concept is developed in a larger area array each individual spot, can be characterized by its spectral response without moving parts provided the positioning of multi-wavelength scanned light in front of each array element and the use of a single large area photo-detector facing the complete array (Fig. 7).

A possibility to speed up the acquisition process and also exploit already existing DNA or similar arrays is to simultaneously illuminate the complete array with a large area screen light and to acquire the collective spectra with an array light detector, like a web camera (Fig. 8).

Of course in applications, like DNA array decoding, the whole set of acquired information obtained in situ can be interpreted on line by an expert system.

As a final example, there is also the chance to obtain true monochromatic light, exploiting the positioning of the light source (a white strip on the screen for instance), by interposing a grating in the optical path, in order to expose the sample to monochromatic light. By accurately moving the light source on the screen the diffracted light is displaced on the sample. In the case of a single detector, if the diffracted light is collimated through a narrow slit, the displacement of the light source provides monochromatic light on the sample (Fig. 10).

The diagram in Fig 10 illustrates the involved variables which yields simple geometrical relations between light source displacements and resolution.

Of course in this simplified picture used to state the concept, we have omitted practical problems which similarly arises in standard monochromators, like the finite size of the source, or the compromise between the limited light intensity and the distance from the screen to enhance the color separation efficiency.

The static monochromatic is not only an example of a device working with the programmable light source, but also an approach to monochromatize light in standard SLPT setups.

In all of these examples the computer screen can be simultaneously used to display test results or for analysis of these results via software on the computer or via internet, since only a part of the screen is used as a light source in a multitasking computer platform.

It should also be pointed out that the large area light source can be focussed to a small area sample, increasing in this way the light intensity on the sample.

One implementation of the invention thus consists of the use of a large area programmable light source together with a detector and a suitable designed test sample which traces the interaction with the analyte in the target environment. The test sample can be, for example, in the form of a cuvette with a suitable liquid indicator, a layer on a transparent substrate or directly the detector gate. The test sample is provided with properties necessary to detect selected species in the environment through a change in its spectral response or through its interaction with the detector, depending on the chosen mode of operation (Fig. 9).

Additionally a method and device to generate true monochromatic light is also provided.

In relation to the prior art the invented method is able to provide practical analytical

applications with inexpensive and simplified versions of well established analytical techniques.

Description of the drawings

Further characteristics and advantages of the invention are apparent from the following description of the old technique as well as from the invented technique described below in conjunction with the drawings.

In the drawings:

Fig. 1.depicts a standard visible absorption spectroscopy setup;

Fig. 2. a standard surface photovoltage spectroscopy setup;

Fig. 3. a standard scanning light pulse technique (SLPT) setup;

Fig. 4. typical spectral distribution of the different RGB color spots in one pixel of a CRT screen;

Fig 5. spectral distribution from a CRT monitor for different R, G and B values;

Fig. 6. screen assisted VIS spectroscopy;

Fig. 7. screen assisted VIS spectroscopy for color identification in absorbing arrays,

Fig. 8. same principle as in Fig. 7, but for the read out method using a digital video camera;

Fig. 9. screen assisted VIS absorption spectra for different liquid samples and SPLT images for different gases, and

Fig. 10. static monochromator primciple.

Fig. 1. Is a standard visible absorption spectroscopy setup. A white light source 1 is

monochromatized and chopped by a chopper 2 and a monochromator. The monochromator is constituted of an input slit 3, a position controlled grating 4, a mirror 5 and an output slit 6. The light leaving the monochromator passes through the test sample 7 in the cuvette 8. The emerging light is detected by a light detector 9 and its intensity displayed on a computer screen 10 as a spectrum. Via an electronic control unit 11 the computer 12 controls the position of the grating 4.

Fig. 2a. Shows a standard surface photovoltage spectroscopy setup. A white light source 1 is chopped 2, monochromatized 3 – 6 and then focused 13 on the semiconductor substrate 15, through the sample environment 17. The signal from the detector is coupled to a computer 12 via an electronic control unit 11, that also controls a grating 4 in the monochromator 3-6. The detector comprises a transparent vibrating electrode 14 over a semiconductor substrate 15 with a metal backside. The measured photocurrent vs. the wavelength is displayed as a diagram on the computer screen 10.

Fig. 2b. Depicts an alternative detector configuration with a transparent metal layer 18 on top of an insulating layer 19 that in turn is on top of a semiconductor layer 20. Alternatively the suspended gate detector structure of fig 2c can be used, where a transparent metal layer 21 is arranged suspended a short distance above a semiconductor substrate 22.

It is also possible to use the detector configuration of fig 2d, with a semiconductor substrate (or powder) 23 sandwiched between two electrodes 24 and 25, of which at least one is transparent.

Fig. 3. Shows a standard scanning light pulse technique (SLPT) setup. A focused chopped monochromatic light beam 31 for instance from a laser is spatially scanned over a metal-insulator-semiconductor (MIS) (alternatively over an ion sensitive device in the so called LAPS) detector 32 with a transparent metal gate, which is simultaneously exposed to the target

environment 36 that is to be analyzed. The measured photocurrent is displayed on the computer screen 10 as a function of the position on the detector. The detector 32 is placed on a x-y-micropositioning table 34 and coupled to the computer 12 via an electronic device 35.

Using for instance a gate with gradients in composition and thickness, there will exist spatially distributed sensitivities and selectivities to different analytes, which are pictured as distinctive chemical images on the computer screen.

Fig. 4. Typical spectral distribution of pure red, green and blue colors displayed on a CRT screen.

Fig. 5. Typical emitted spectral distribution from a CRT monitor when different sets of rgb values are chosen to imitate the perception of the visible spectrum.

Fig. 6a. Programmed screen assisted VIS spectroscopy. The same display 60 used as control interface provides colored light 61 according to Fig.5 which is passed through a test sample 62 and the emerging light is captured by a detector 63 coupled to the computer via a electronic device 64 plotting the resulting spectra in the same computer display. In Fig 6b a different test sample 65 printed or deposited on a glass or polymer substrate 66, but used in the same way as in Fig.6a is illustrated.

Fig. 7. Programmed screen assisted VIS spectroscopy for color identification of chemically sensitive arrays. The same display used as control interface provides colored light according to Fig.5, in selected regions of the screen facing individual elements of the sample array. For instance, a glass substrate 71 is suspended on a portion of the screen 72. On this glass substrate a DNA labeled array 73 face the screen and on the other side of the substrate a single large area

photodetector 74 is arranged covering the entire area of the DNA labeled array. The photodetector delivers its signals to an electronic interface 75 that delivers the signal to the computer 76. The screen under the glass substrate constitute a large area light emitting window 77, that in turn can illuminate the different elements of the array (one at time) with modulated multiple wavelength light. For each element on the glass substrate a multi-wavelength spectral response can be recorded. The resulting spectra are displayed in the same computer screen. Expert evaluation of data and array interpretation can be provided by the computer itself or on line via internet. Additionally, if necessary it is possible to focus the light from the screen using diffractive or refractive lenses between the screen and the sample.

The example was a DNA array but the method is applicable to any array based analysis utilizing the optical properties of the different spots of the array.

Fig. 8. Same principle as in Fig. 7, but the acquisition process is enhanced illuminating the whole sample array simultaneously and capturing the information with a detector array 81 provided by a video camera (web camera). Additionally if necessary it is possible to focus the light from the screen by using diffractive or refractive lenses between the screen and the sample, and/or between the sample and the camera. The incorporation of filters for particular applications can also be envisaged, in both Fig. 7 and 8.

Fig. 9. VIS absorption spectra for different concentration of blue aniline, orange acridine, and fluorescent fluorescein-sodium from top to bottom on the left, and on the right SLPT images obtained using a Pt-Pd gate detector when it is exposed to dry air, hydrogen or ammonia as target environments. Note the contribution of the fluorescence to the recorded spectra in the bottom left diagram.

Fig.10. Static monochromator principle. A point light source at a distance x from the origin 0, is displaced on the surface S_o subtending a variable angle α, with the normal of the transmission grating at a constant angle θ respect to S_o.

The grating pitch d and the angle α, determines the emerging angle β for each particular wavelength λ at the diffraction order m. In this way the complete spectrum is decomposed along a distance Δy_m on a surface S_I at a distance $a_0 + a_I$ from the surface S_0. If a collimating slit, with an slit width w, is placed on S_I, when the light source is displaced in x, the different components of the spectrum emerges though the slit illuminating the sensor.

If the slit is omitted there is a possibility to use an array detector in the same place and in principle obtain a full spectrum with a resolution also given by the number and size of the array detector.

Claims

1. Method **characterized in**, the use of a program controlled display as a light source, for test and experiments.

2. Method according to claim 1 **characterized in**, the light source is composed by one or more activated pixels in a computer, TV or any other active screen.

3. Method according to claim 1 **characterized in**, the illuminating area is displaced without requiring mobile parts.

4. Method according to claim 1 **characterized in**, the light intensity of each individual pixel is individually modulated by software.

5. Method according to claim 1 **characterized in**, the screen color of each pixel is individually scanned within the visible range by software.

6. Method according to any of the claims 1-5 **characterized in**, the color, size, shape, modulation and background color of the light source is configured through the user interface.

7. Method according to any of the claims 1-6 **characterized in**, a program controlled light source illuminates a detector or a detector through a test sample, which tracks the interaction with a target analyte in the test environment, affecting the detected signal.

8. Method according to claim 7 **characterized in**, the test sample itself is chemically or bio-

chemically modified to change its spectral response, upon interaction with the target analyte.

9. Method according to claims 7 or 8 **characterized in**, a custom designed optics is inserted in the light path to enhance spatial resolution and detection limits.

10. Method according to any of the claims 7-9 **characterized in**, the light detector is a unique element or an array of multiple detectors as in a web camera.

11. Method according to any of the claims 7-10 **characterized in**, the same computer controls the complete device: light source, instrumentation and configuration interface providing as result a spectrum or a chemical image or any other property of the sample substance which is displayed on the same screen.

12. Method according to any of the claims 7-11 **characterized in**, the computer also provides the evaluation of the observed properties locally or by an internet connection.

13. Method according to any of the claims 7-12 **characterized in**, the acquisition performed in situ is evaluated by an expert on line e.g., via internet.

14. Method according to any of the claims 7-13, **characterized in** that the detected results are displayed on a part of the screen that is not used for illuminating the detection device.

15. Method according to any of the preceding claims **characterized in,** that all of the operating modalities can be performed simultaneously.

16. Method according to claim 3 **characterized in,** that a diffractive element is placed in front of the moving light source thus providing an outgoing spectrum of colors.

17. Method according to claim 16 **characterized in**, that diffracted light is scanned through a collimating slit by controlled displacements of the light source.

18. Method according to claim 16 **characterized in**, that the diffractive element can be a transmission grating, a reflection grating or a prism, depending on the chosen geometry.

19. Method according to claim 17 **characterized in**, that the collimating slit can be replaced by an array detector.

20. Device **characterized in**, that it is specifically designed to utilize the light supplied by a program controlled display, working in any of the methods above.

21. Device according to claim 20 **characterized in**, that it is an optical component (lens, grating, filter, etc.).

22. Device according to claim 20 **characterized in**, that it is a detector of light.

23. Device according to claim 20 **characterized in**, that it is interacting with the test environment.

24. Device according to claim 20 **characterized in**, that it contains molecules or materials specifically designed to show spectral changes upon chemical or bio-chemical reactions.

25. Device according to claim 24 **characterized in**, that it contains molecules or materials specifically designed to be used together with rgb-color illumination.

26. Device according to claim 20 **characterized in**, that it utilizes the display as a large area light source, to illuminate a large area sample and thereafter a focussing lens in front of a detector.

27. Device according to claim 20 **characterized in**, that it utilizes the screen as a large area light source, which is focussed onto a small area sample, with or without a magnifying lens in front of the detector.

28. Device for the execution of the method of claim 7 **characterized in**, that it utilizes a display as a light source, and a holder for holding a test sample at a given distance from the display.

29. Device according to claim 28 **characterized in**, that a lens, or a grating is inserted between the sample holder and the display.

30. Device according to claim 28 **characterized in**, that a light detector is arranged viewing the test sample.

31. Device according to claim 28 **characterized in**, that it is a focussing lens between the screen and the sample holder.

32. Device according to claim 28 **characterized in**, that it is a magnifying lens between the

sample holder and the detector.

33. Device **characterized in**, that it combines the claims 31 and 32.

34. Device according to claim 28 **characterized in**, that the test sample is interacting with the test environment.

35. Device according to claim 28 **characterized in**, that the test sample contains molecules or materials specifically designed to show spectral changes upon chemical or bio-chemical reactions.

36. Device according to claim 28 **characterized in**, that it contains molecules or materials specifically designed to be used together with rgb-color illumination.

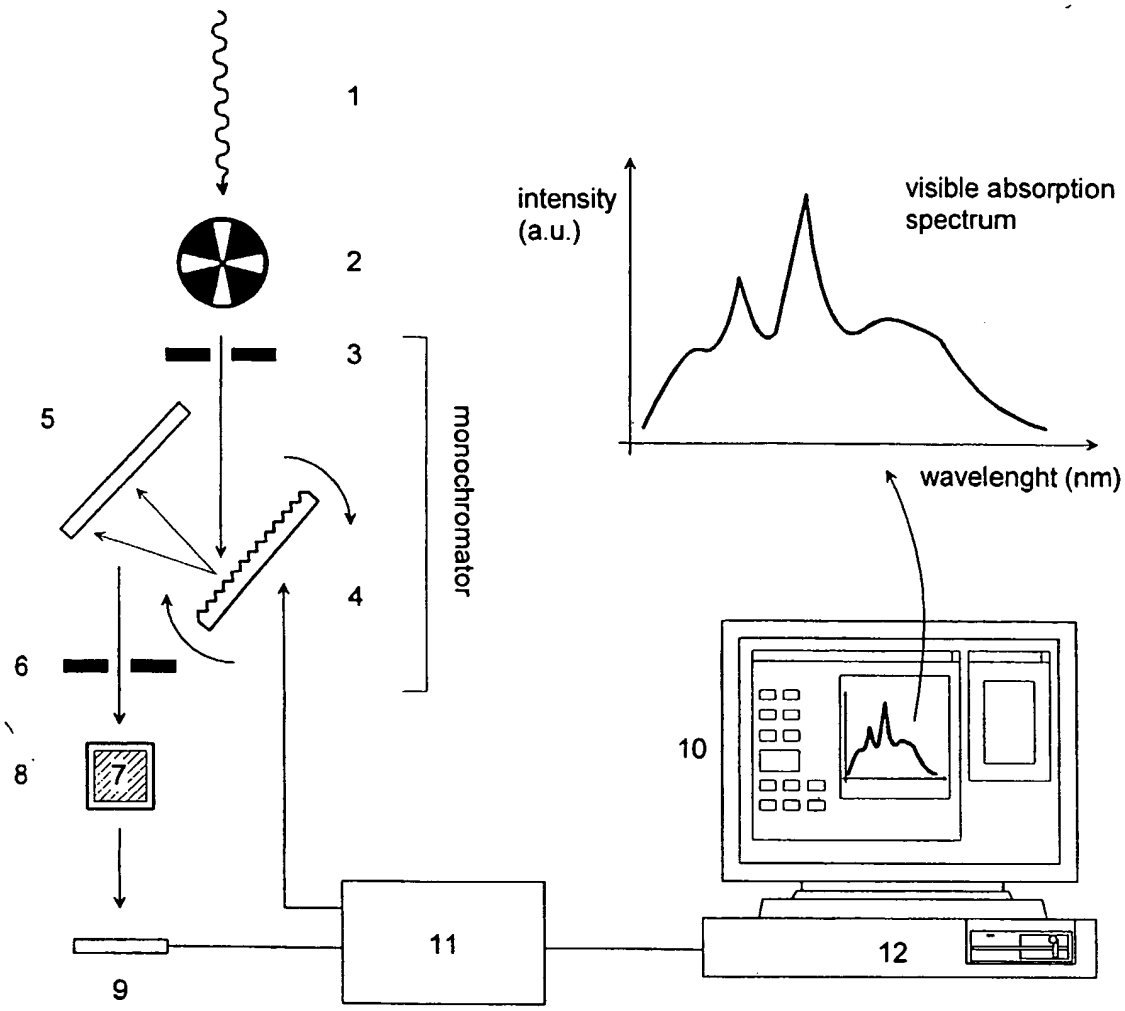
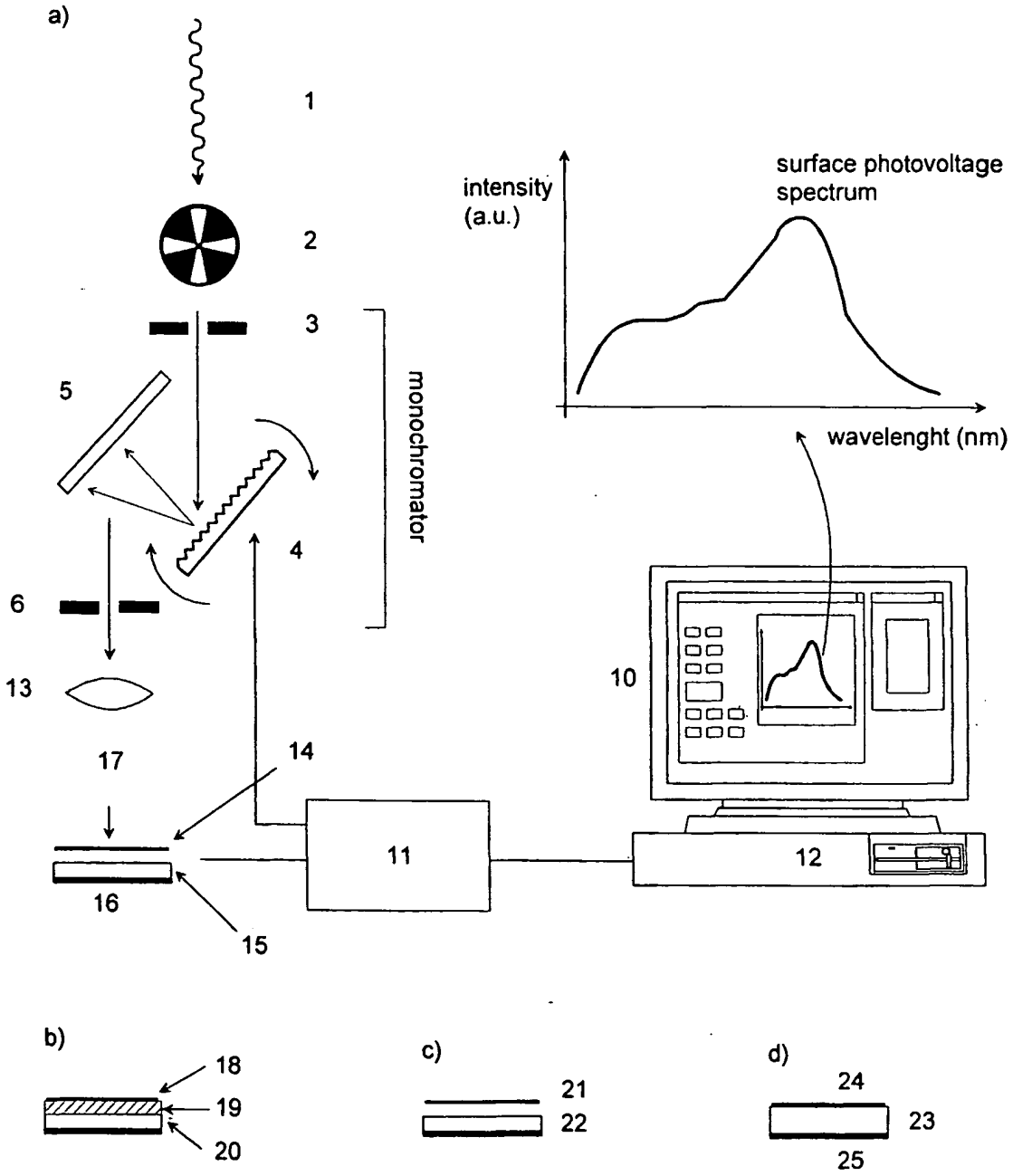


Fig. 1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surface photovoltage
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Fig. 2

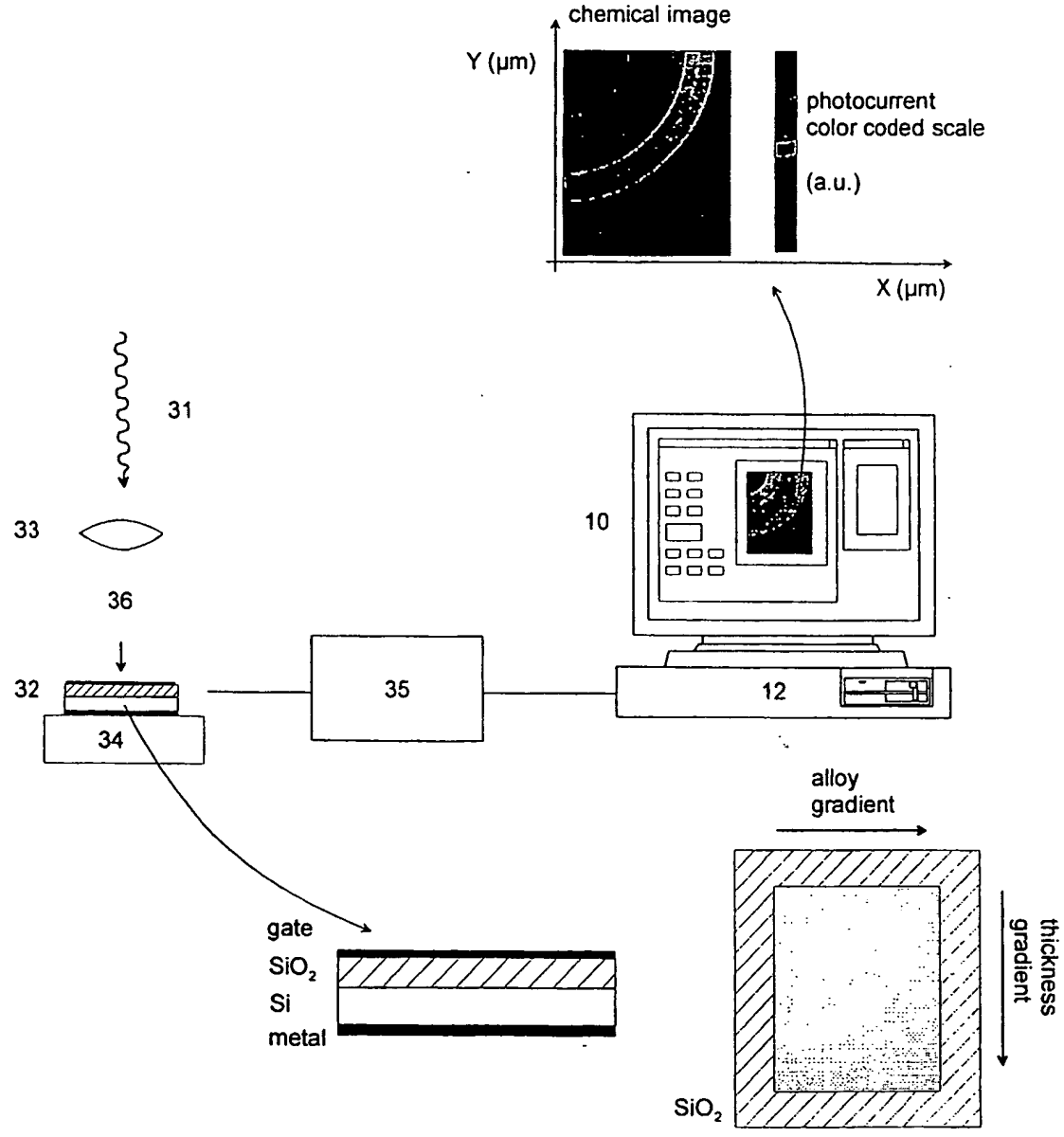

Fig. 3

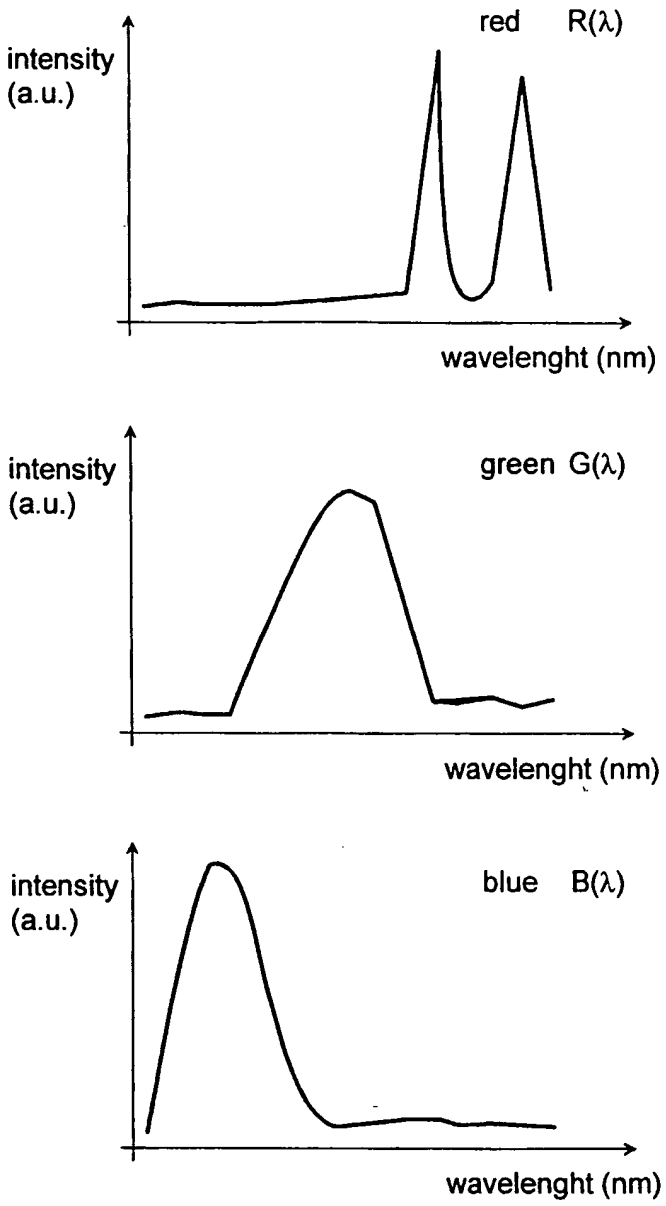

Fig. 4

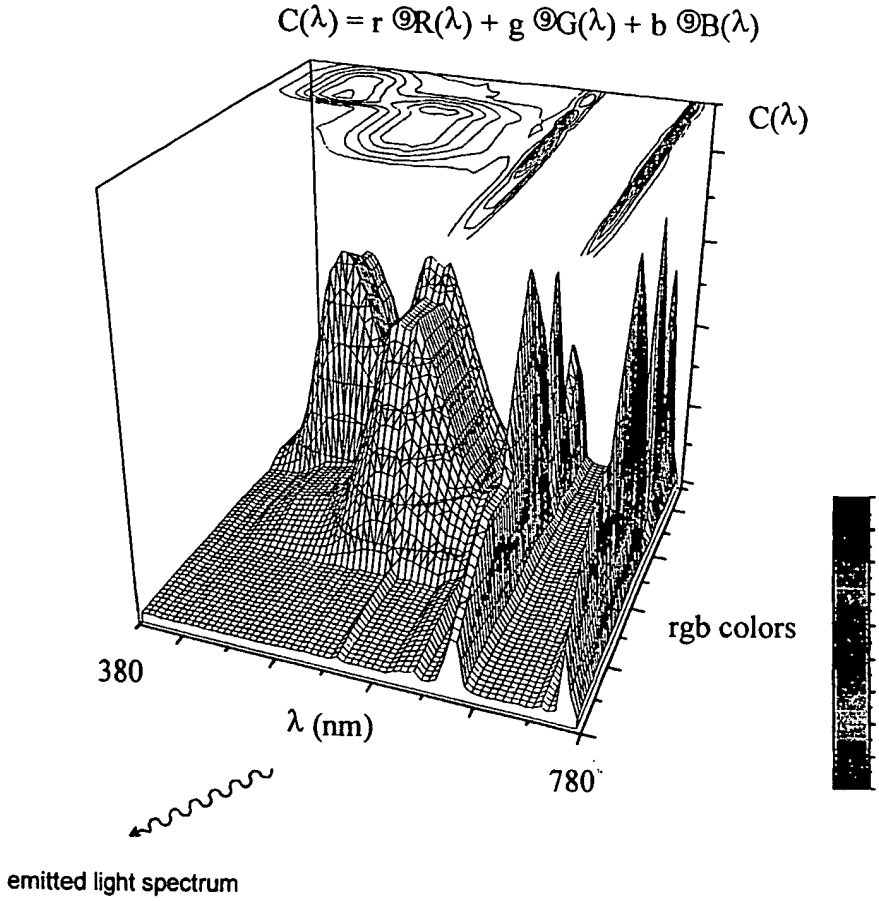

Fig. 5

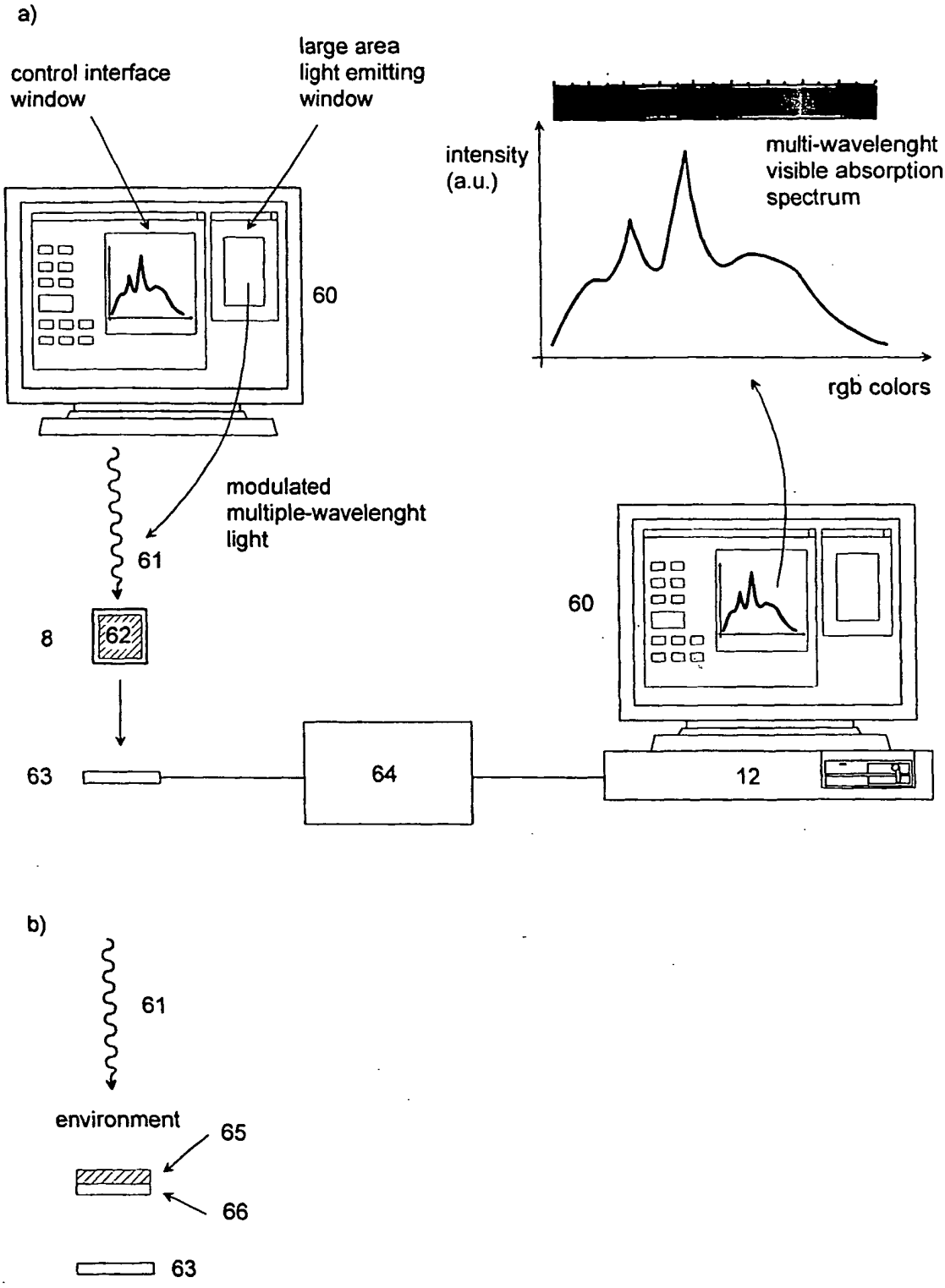
a)
control interface window
large area light emitting window
60
modulated multiple-wavelenght light
61
8
62
63
64
12
60
intensity (a.u.)
multi-wavelenght visible absorption spectrum
rgb colors
b)
61
environment
65
66
63

Fig. 6

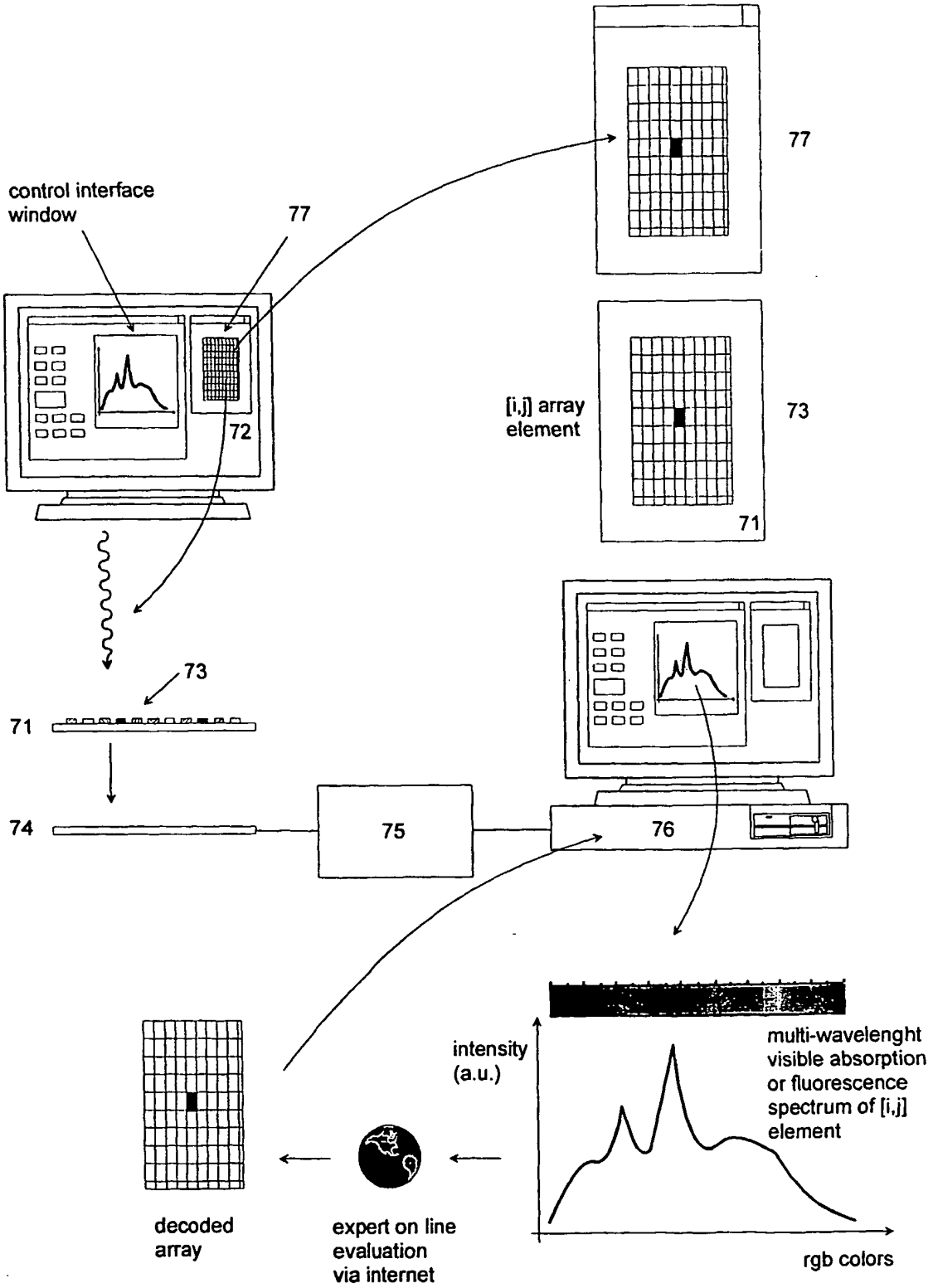

Fig. 7

10/501935

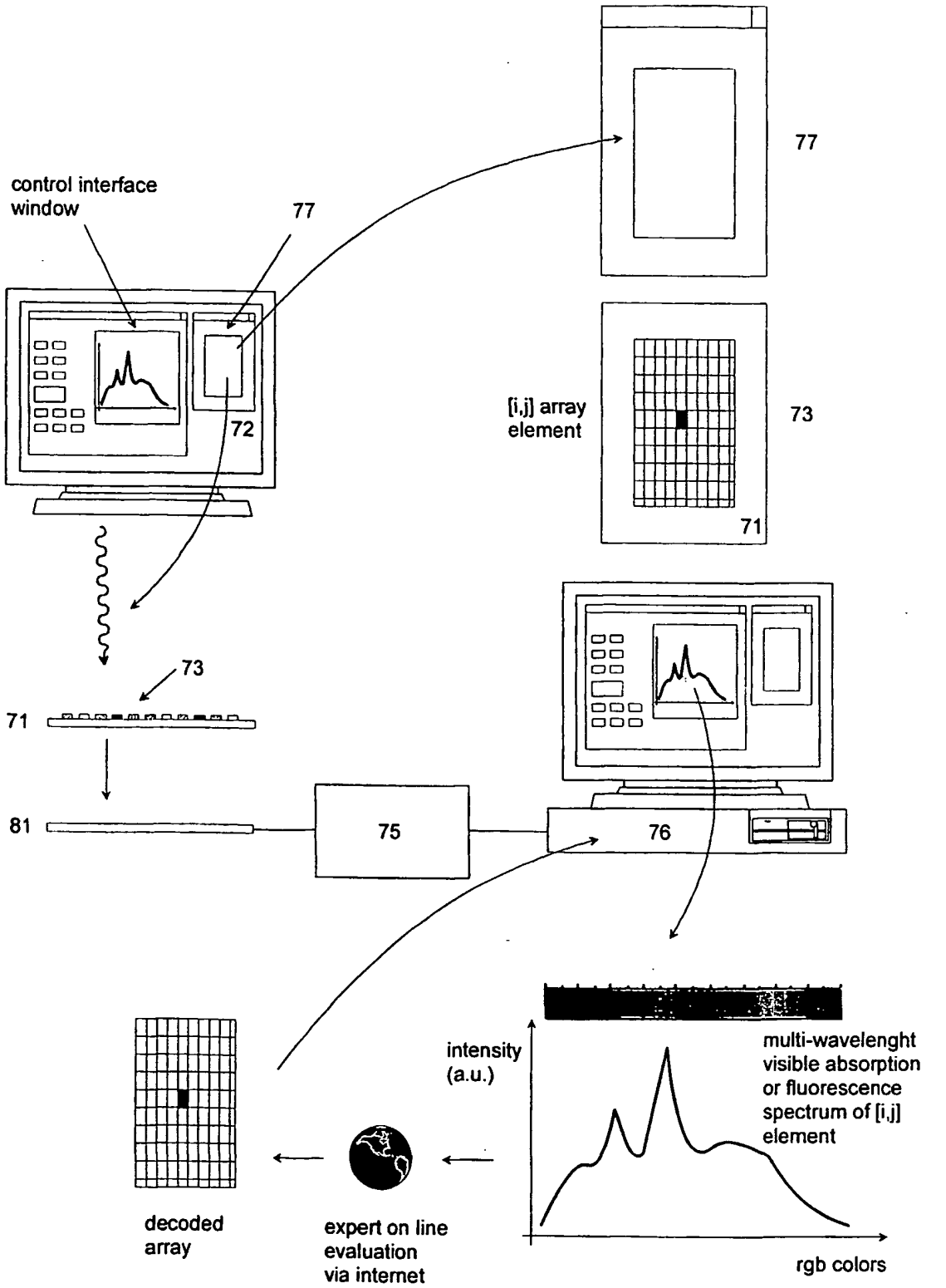

Fig. 8

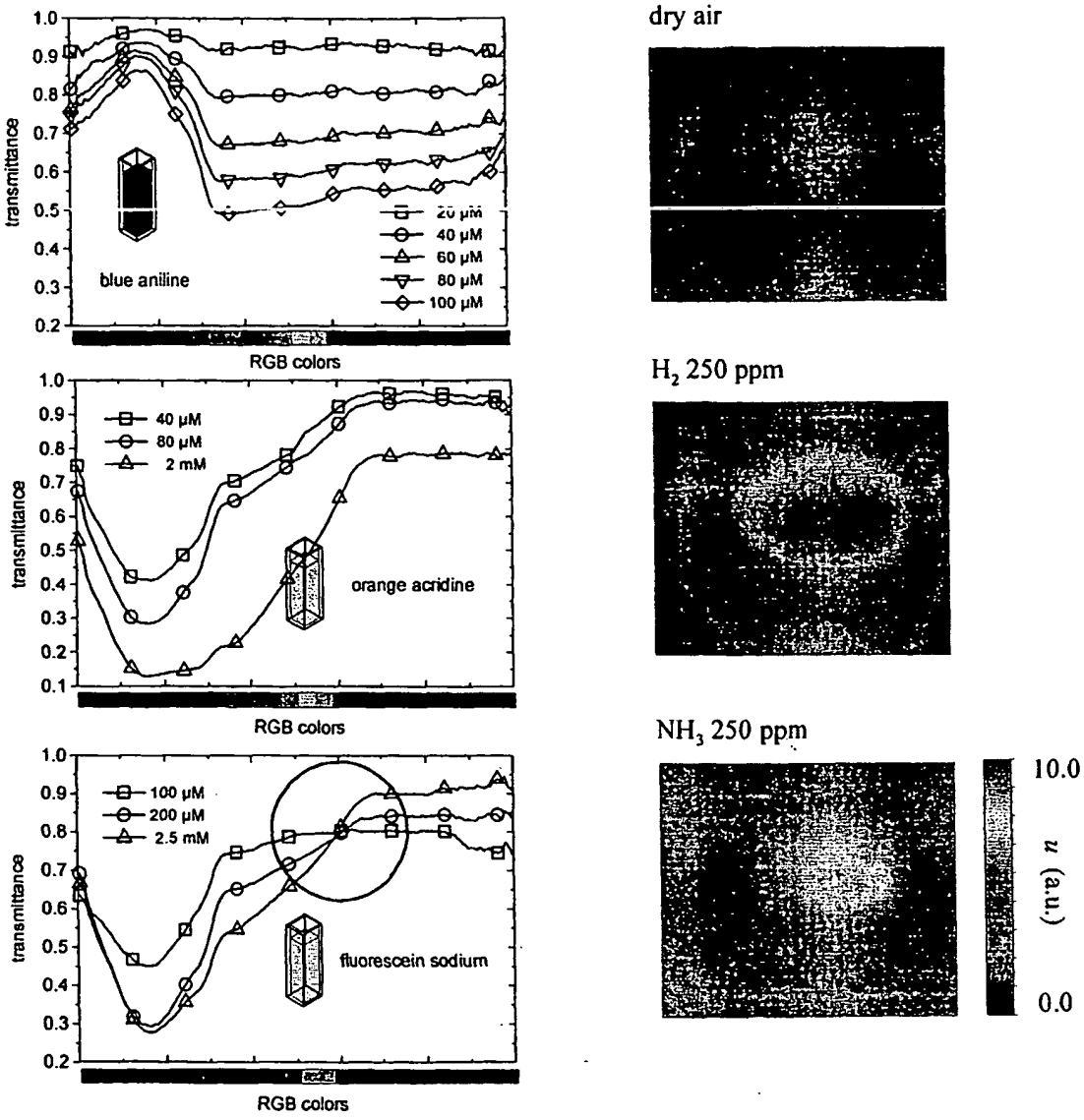

Fig. 9

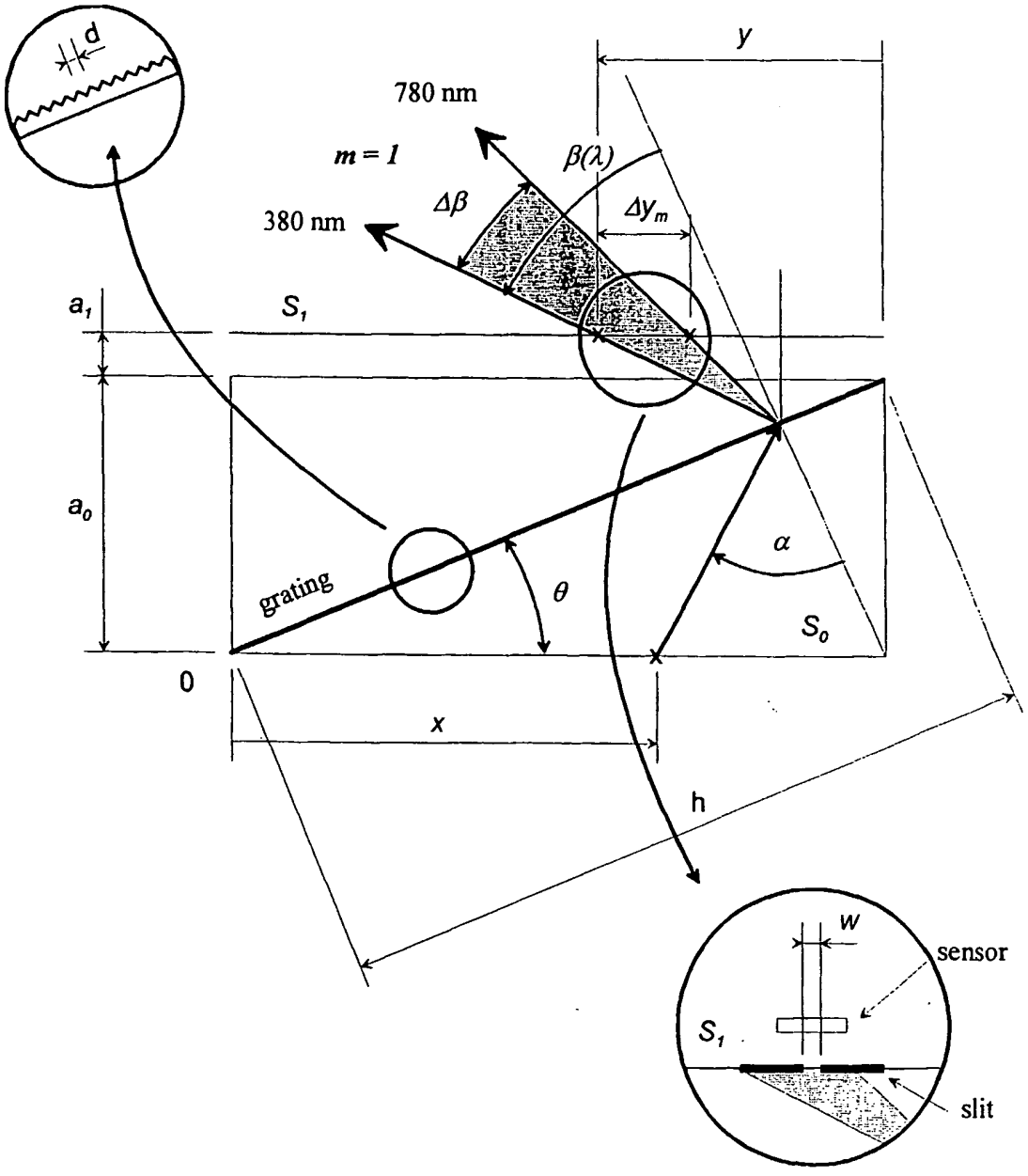

Fig. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 02/00207

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H05B 43/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: G01N, H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL,WPI DATA

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5372502 A (R.MASSEN ET AL), 13 December 1994 (13.12.94), column 3, line 25 - line 41; column 3, line 47 - line 54; column 4, line 67 - line 68, col.5,lines 1-22,col. 7,lines 18-23	1-6
Y	see the whole document this reference has been replaced by US 4,875,771 in agreement with examiner!	17, -31,
Y	US 5386112 A (A.E.DIXON), 31 January 1995 (31.01.95), see the whole document	17, -31,
A	US 5418614 A (DALE F.BROST ET AL), 23 May 1995 (23.05.95), abstract	13

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 Sept 2002	26-09-2002
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Anna Lundqvist /itw Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE02/00207

Box I **Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 33
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II **Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT
Information on patent family members

02/09/02

International application No.
PCT/SE 02/00207

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5372502 A	13/12/94	CH 680187 A	15/07/92
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		CN 1074292 A	14/07/93
		EP 0533333 A	24/03/93
		JP 5203561 A	10/08/93

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(25) Filing Language: English

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(71) Applicants and
(72) Inventors: **FILIPPINI, Daniel** [AR/SE]; Ulvåsavägen 4B, S-582 47 Linköping (SE). **LUNDSTRÖM, Ingemar** [SE/SE]; Färgaregatan 10, S-582 52 Linköping (SE).

(74) Agent: **STRÖM & GULLIKSSON IP AB**; Wallenbergs gata 4, S-583 35 Linköping (SE).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

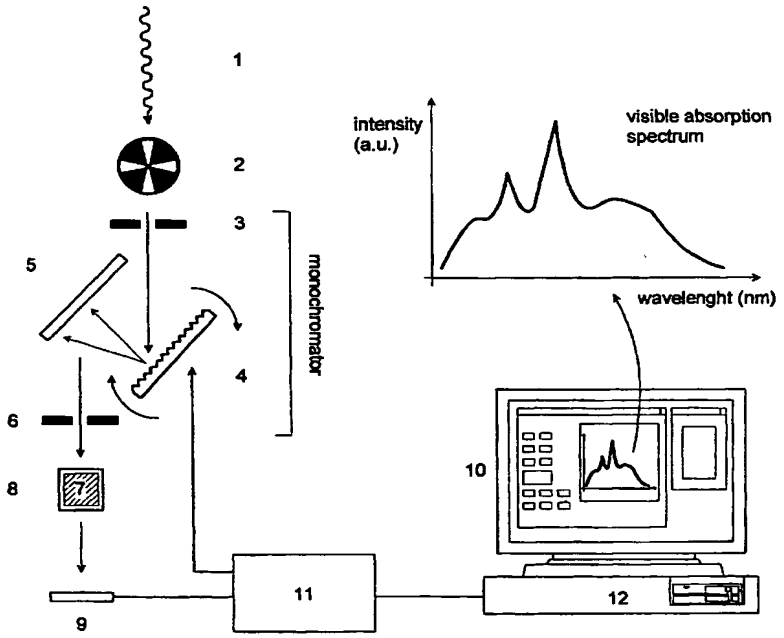
Published:
— *with international search report*

(88) Date of publication of the revised international search report: 27 May 2004

(15) Information about Correction:
see PCT Gazette No. 22/2004 of 27 May 2004, Section II

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: TEST METHOD



(57) Abstract: This invention relates to a practical low cost method and devices which exploits the benefits of several photo-assisted analytical techniques involving controlled light sources. The method comprise the use of a program controlled display (like computer, mobile telephones to TV screens) used as a light source for illuminating a detector specially suited to capture the light interaction with a test environment, allowing to generate distinctive spectra and chemical or biochemical images of the environment. Additionally, the information can be acquired in situ but immediately analyzed on line via internet.

WO 2003/067936 A1

REVISED VERSION

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 2002/000207

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H05B 43/00
According to International Patent Classification (IPC) or to both national classification and IPC

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Minimum documentation searched (classification system followed by classification symbols)

IPC7: G01N, H05B

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EPO-INTERNAL,WPI DATA

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Y	see the whole document	7-12,15-17, 19-24,28-31, 34-35
	--	
Y	US 4875771 A (H.J.BOWLEY ET AL), 24 October 1989 (24.10.1989), see the whole document	7-12,15-17, 19-24,28-31, 34-35
	--	

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 January 2004	30 -01- 2004
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Anna Lundqvist /itw Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 2002/000207

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5418614 A (DALE F.BROST ET AL), 23 May 1995 (23.05.1995), abstract -- --------	13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE02/00207

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

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because they relate to subject matter not required to be searched by this Authority, namely:

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because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 33
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

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2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

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4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT
Information on patent family members

24/12/2003

International application No.
PCT/SE 2002/000207

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				JP	5203561	A 10/08/1993